

CLAIMS

What is claimed is:

1. A transceiver module for both transmitting and receiving optical data over single fiber-optic cable in a fiber-optic network, the transceiver module comprising:

a substrate;

an active component part comprising a laser diode and a photo diode disposed on the substrate; and

a circulator disposed on the substrate and optically coupled to the active component part, the circulator having a first port optically coupled to the laser diode, wherein optical data input at the first port is output at a second port, the second port for transmitting and receiving optical data from the fiber-optic network, where optical data input at the second port is output at a third port that is optically coupled to the photo diode.

2. The transceiver module set forth in claim 1, the active part being monolithically formed on the substrate.

3. The transceiver module set forth in claim 1, the active part comprising a discrete laser diode and a discrete photo diode bonded to the substrate.

4. The transceiver module set forth in claim 1, the active part being bonded with epoxy to the substrate.

5. The transceiver module set forth in claim 4, the active part coupled to the circulator through free space.

6. The transceiver module set forth in claim 1, the active part coupled to the circulator through at least one fiber-optic pigtail, the laser diode being coupled to the circulator through a polarization maintaining fiber.

7. The transceiver module set forth in claim 1, the second port optically coupled to an output connector.

8. The transceiver module set forth in claim 1, the output connector being at least one of small form factor, small form factor pluggable, and GBIC.

9. The transceiver module set forth in claim 8 further comprising an electronic interface coupled to the laser diode and the photo diode, the electronic interface comprising circuitry for converting electronic data signals into a driving signal for driving the laser diode and for converting signals from the photo diode to electronic data signals.

10. The transceiver module set forth in claim 1 the electronic signals being 10 Gigabit Ethernet.

11. The transceiver module set forth in claim 1 wherein the circulator includes a core, the core comprising:
- a first wedge;
 - a faraday rotator optically coupled to the first wedge;
 - a second wedge optically coupled to the faraday rotator; and
- wherein the first wedge, second wedge, and faraday rotator are arranged such that the core is optically non-reciprocal in transmit and receive directions.
12. The transceiver module set forth in claim 11 wherein the Faraday rotator comprises a non-latching magnetic material.
13. The transceiver module set forth in claim 11 wherein the Faraday rotator comprises a latching magnetic material.
14. The transceiver module set forth in claim 11 wherein the first and second wedges are one or more of Wollaston, Rochon, Glan-Thomson and Glan-Taylor prisms.
15. The transceiver module set forth in claim 11 wherein the first and second wedges are thin film cubes.

16. The transceiver module set forth in claim 1 wherein the circulator comprises:

- a plurality of polarization beam splitters;
- a plurality of garnets in optical communication with the plurality of polarization beam splitters;
- at least one waveplate in optical communication with the plurality of polarization beam splitters and the plurality of garnets; and
- at least one mirror in optical communication with the plurality of polarization beam splitters, the plurality of garnets and the at least one waveplate.

17. The transceiver module set forth in claim 1 wherein the circulator comprises:

- a polarization beam splitter;
- a waveplate optically coupled to the polarization beam splitter;
- a garnet optically coupled to the waveplate; and
- a beam displacer optically coupled to the garnet.

18. The transceiver module set forth in claim 1 wherein the circulator comprises:

- a first waveplate;
- a first beam displacer optically coupled to the first waveplate;
- a second waveplate optically coupled to the first beam displacer; and
- a second beam displacer optically coupled to the second waveplate.

19. In an optical network environment, a method of fabricating a bi-directional transceiver module, the method comprising:

providing a substrate;

attaching an active component part to the substrate, wherein the active component part includes a laser and a photodiode; and

attaching a circulator on the substrate such that a first port of the circulator is coupled with the laser and wherein a second port of the circulator is coupled with the photodiode.

20. The method as set forth in claim 19, wherein constructing a circulator on the substrate further comprises:

attaching a first wedge to the substrate;

attaching a Faraday rotator to the substrate, wherein the Faraday rotator is in optical communication with the first wedge;

attaching a second wedge to the substrate wherein the second wedge is in optical communication with the Faraday rotator.

21. The method as set forth in claim 19, further comprising coupling the first port to the laser through free space.

22. The method as set forth in claim 19, further comprising coupling the first port to the laser through free space and coupling the second port to the photodiode through a fiber optic pigtail.

23. The method as set forth in claim 19, further comprising the laser to the circulator through a polarization maintaining fiber-optic pigtail.

24. The method as set forth in claim 19, wherein attaching an active component part to the substrate further comprises fabricating the active component part monolithically onto the substrate.

25. The method as set forth in claim 19, wherein attaching an active component part to the substrate further comprises attaching discrete components to the substrate.

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

26. A transceiver module for both transmitting and receiving optical data over single fiber-optic cable in a fiber-optic network, the transceiver module comprising:

an active component part including a laser diode and a photo diode disposed on a substrate that are separated by a distance, wherein the distance between the laser diode and the photo diode determines a length of the transceiver module; and

a core that is connected to the laser diode over a polarization maintaining fiber and to the photo diode over a single mode fiber, wherein the core transmits light from the laser diode to a fiber optic cable over a first path through the core and transmits light received from the fiber optic cable to the photo diode over a second path through the core.

27. A transceiver module as defined in claim 26, wherein the distance between the laser diode and the photo diode is less than 300 microns.

28. A transceiver module as defined in claim 26, wherein the distance between the laser diode and the photo diode is about 200 microns.

29. A transceiver module as defined in claim 26, wherein the length of the transceiver module is less than .75 inches.

30. A transceiver module as defined in claim 26, wherein the length of the transceiver module is about .5 inches.

31. A transceiver module as defined in claim 26, wherein the core includes a garnet that is disposed between a first wedge and a second wedge.

32. A transceiver module as defined in claim 31, wherein the core is enclosed by a magnet.

33. A transceiver module as defined in claim 31, wherein the core further comprises:

a first lens disposed between the first wedge and the active component part; and

a second lens disposed between the second wedge and the fiber optic cable.

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